High Throughput Assessment of Nanoparticle Penetration of Skin

One of the major concerns over the widespread use of nanoparticles is the degree of nanoparticle absorption through skin. NIST's expertise in method development, imaging, and microanalysis is being leveraged to develop efficient and accurate methods for detecting and quantifying nanoparticles in skin. A high throughput penetration study method was developed to address the time-dependent quality control issues and the difficulties in procuring sufficient skin samples for this type of multivariate experiments.

K. Scott (Div. 837)

In recent years, the number of products containing nano-sized materials has been increasing steadily because nanoparticles exhibit unique, size-dependent physical and chemical properties that are useful in pharmaceutical, cosmetics, and other industrial applications. However, these unique properties can have unexpected health and environmental effects. One of the major concerns over the widespread use of nanoparticles is the degree of nanoparticle absorption through skin. Although skin is a very effective barrier against most environmental contaminants, several studies have shown that nanoparticles can penetrate skin effectively when they are surface functionalized with charged moieties. When used as a topical drug delivery vehicle, such good skin penetrability is a desirable trait while the opposite is the case if nanoparticles are produced as industrial pollutants.

Proper assessment of nanoparticle penetration of skin requires evaluation of skin exposures to different nanoparticles in varying concentrations and environmental conditions. Currently there is no standard method to detect and quantify nanoparticle penetration of skin. Most evaluations of this type are carried out by individual companies, often resulting in incomplete and inconsistent data and analyses. Such inconsistency and heterogeneity in data make it difficult for regulatory agencies to make informed decision about the safety of nanoparticle based products.

A high throughput penetration study method was developed to address the time-dependent quality control issues and the difficulties in procuring sufficient skin samples for this type of multivariate experiments.

This method allows dozens of experimental conditions to be tested simultaneously on a 70mm diameter piece of skin sample, see Figure 1. Preliminary experiments were performed on artificial skin samples where the samples were exposed to solutions of several types of quantum dots at several concentration levels. After 24 hours of incubation, the samples were fixed and processed for fluorescence and electron microscopy.

The results from the preliminary analyses confirmed that multiple dosing conditions can be evaluated simultaneously without cross talk between the wells.

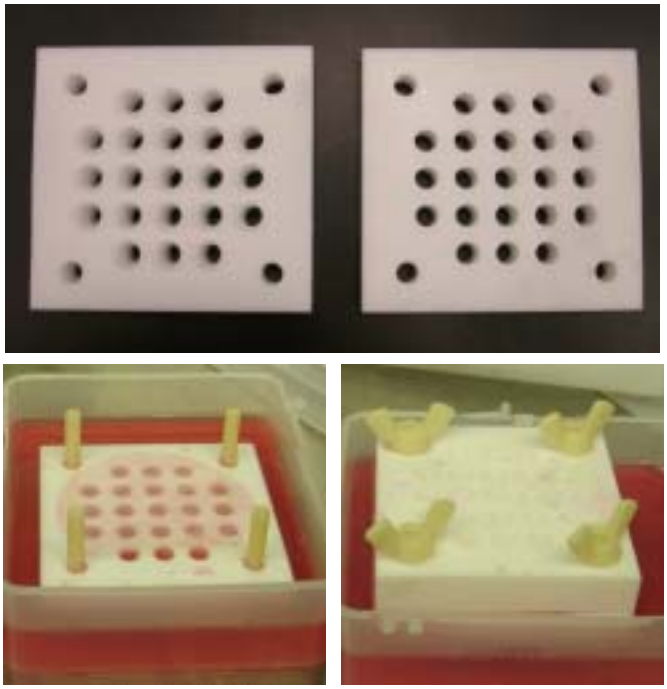

Figure 1: a) High-throughput diffusion plates, b) skin sample exposed to growth medium at the bottom, c) assembled plates

Future Plans: In addition to the optimization of the method and apparatus design to allow for multiple post processing options such as the use of different fixation methods or live cell stains, sample preparation and analysis techniques and methods for accumulated nanoparticle detection and quantification will be developed.